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Burlington
PUBLIC WORKS

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1990 WATER QUALITY REPORT

SUMMARY OF RESULTS

FOR THE

BEACH/SWIM SEASON

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1% FOR PEACE

SUMMARY OF WATER QUALITY RESULTS FOR THE 1990 BEACH/SWIM SEASON

INTRODUCTION

This document serves as a summary of the data compiled during the 1990 beach season. In accordance with this year's water quality monitoring program (revision B, June 1990), it contains bacteriological results of Burlington's public beaches plus the streams which discharge into the vicinity of these beaches, including Englesby Ravine. Data has also been collected on the Winooski River both upstream and downstream of Burlington's East and North Wastewater Treatment Plants.

BACTERIOLOGICAL TESTS

The types of bacteriological tests performed vary for the first time this year. In addition to the standard Fecal Coliform test, certain samples were run for Fecal Streptococcus and Escherichia Coli (E. Coli) bacteria. These two strains of bacteria are actual forms of pathogenic organisms instead of Fecal Coliform, which merely serves as an indicator organism for pathogenic material. The reasons for trying these strains of bacteria are twofold: (1) A 1984 EPA document titled "Health Effects Criteria for Fresh Recreational Waters" found a correlation between E. Coli concentrations and gastrointestinal illnesses in exposed swimmers whereas there was no correlation using Fecal Coliform results. (2) A Fecal Coliform to Fecal Streptococcus (FC/FS) ratio was completed on stream samples to try and determine if the contamination was due to human or animal activity.

REPORT OBJECTIVE

The volume of data presented here in summary sheets makes complex analyses difficult, however we will try to answer the following questions:

- Are high bacteriological results on the Winooski River being caused by other sources or Burlington's wastewater plants.
- Is the contamination of streams discharging into the vicinity of Burlington's beaches coming from human or non-human origin.
- Can we determine the approximate location of stream contamination.
- Are high beach counts and subsequent closings the result of these streams, combined sewer overflows or a combination of both.

- Is E. Coli or Fecal Coliform the most accurate and repeatable bacteriological test to perform.

- Should we use the State of Vermont's E. Coli limit for wastewater effluent on beach samples or should we adopt a different limit based on the above mentioned EPA report.

WINOOSKI RIVER SAMPLES

Samples were taken both upstream and downstream of North and East treatment plants on the Winooski River which were then run for fecal coliform. At the same time, effluent samples from the plants were also run. In order to separate the data into usable information, dry weather and wet weather conditions are summarized below. Dry weather is set as rainfall less than or equal to 0.1 inches of rain within 2 days prior to the samples being taken. Wet weather is defined as more than 0.1 inches of rain within 2 days prior to the samples being taken. This definition of dry versus wet weather has been based upon elevated levels of bacteriological contamination in the Winooski River. A summary of results is shown below:

FECAL COLIFORM RESULTS (colonies per 100 mls of sample)

DRY WEATHER (rainfall ≤ 0.1 " within 2 days prior)

North Plant			
Upstream	122 ave	300 high	30 low
Downstream	91 ave	190 high	30 low
East Plant			
Upstream	181 ave	360 high	30 low
Downstream	36 ave	140 high	<1 low

WET WEATHER (rainfall > 0.1 " within 2 days prior)

North Plant			
Upstream	1318 ave	2400 high	240 low
Downstream	1098 ave	1860 high	280 low
East Plant			
Upstream	788 ave	1880 high	130 low
Downstream	893 ave	2060 high	<1 low

As expected, the wet weather counts are invariably higher than dry weather. This shows that stormwater runoff into the Winooski is indeed contributing to bacteriological contamination. During this sampling period the fecal coliform counts from both plants averaged one colony with a high

of four colonies. With the exception of wet weather data for East plant, the downstream counts were consistently lower than upstream. This is caused by the dilution effects of effluent with low coliform counts and the die-off of bacteria, to a smaller extent.
According to East plant personnel, there is no stormwater outfall between the plant's discharge point and the downstream sampling point which could add contamination. For some reason, two out of four wet weather samples had larger downstream values than upstream, however this is no cause for concern.

BEACH RESULTS

Beach samples were run for Fecal Coliform from North, Leddy and Oakledge beaches between May 31st and September 7th. The number of sampling times is different for each beach because of repeat samples after a violation occurred and the fact that North beach was open longer than the others. The results for each beach are summarized below with summary sheets and graphs for the months of June, July and August attached in Appendix A at the end of this report. Also, during the month of August, all beaches were tested for the presence of E. Coli. Later on we will try to attribute the source of high coliform counts.

North Beach

Fecal Coliform
Forty-two (42) samples were taken from the north and south ends of North beach between May 31st and September 7th.
The north end had 7 violations of the Fecal Coliform limit out of 42 (17% violation) with only one that couldn't be attributed to a rain event as defined earlier. The violations ranged from 240 to 1700 colonies.
The south end had 12 violations (29%) with three that again could not be attributed to rain events. High counts ranged from 220 to 1000 colonies.

E. Coli
Nine (9) samples were run for E. Coli between August 2nd and August 17th. The north and south ends had 4 violations of the 77 col/100 ml limit, all attributed to wet weather.

Leddy Beach

Fecal Coliform
Twenty-two (22) samples were taken from the north and south ends of Leddy beach between June 18th and August 17th.
The north end had no violations. The south end had one violation which may have been caused by a rain event.

E. Coli
The north end had 3 and the south had 4 violations out of seven (7), each having a high count on Aug. 17th, when rain was recorded at Main plant but not at North plant.

Oakledge Beach

Fecal Coliform
Twenty-three (23) samples were taken from the north, south and cove of this beach between June 18th and August 15th.
The north end had 7 violations (30%) with one not caused by a rain event.
The south end had 5 violations (22%) with two not caused by precipitation.
The cove had 4 violations (17%) with three that couldn't be attributed to a rain event.

E. Coli
The north, south and cove areas had 2, 1 and 1 violations respectively out of four (4) samples. All could be attributed to wet weather conditions.

COMBINED SEWER OVERFLOWS (CSO)

By definition, a CSO is said to have occurred when the stormwater flows are high enough to cause both storm and untreated wastewater to bypass the Main treatment plant and discharge directly into Lake Champlain in order to protect the plant from damage. Although it is difficult to know when stormwater contains raw sewage, it is likely that a CSO has occurred when the flow into Main plant has exceeded 7 MGD for more than 4 hours. Note, however, that these estimates did not always coincide with high total daily rainfall measurements at Main plant. CSOs are more a function of the intensity of a storm rather than the quantity that fell. For instance, a 0.25" recording in an hour can potentially be more devastating than 1" of rain over four hours. Using this assumption, 12 CSOs were recorded for the months of June, July and August of 1990. The dates are shown below:

Combined Sewer Overflows (Q > 7 MGD for > 4 hours)
June 3, 21, 22, 23, 29
July 20, 23, 31
August 6, 10, 27, 28

This information will be used later to interpret beach results.

BEACH STREAMS

Streams feeding into each of these beaches were tested on a periodic

basis for Fecal Coliform (FC), Fecal Streptococcus (FS), and E. Coli (EC) and were found to be quite contaminated. There is one stream feeding into North beach, which has been designated as north stream. There are two streams feeding into Leddy beach, designated Leddy Stream North and South. Finally, the mouth of Englesby Ravine is located at the extreme north end of Oakledge beach. Samples of Englesby were taken at six locations from the head to the mouth. Also, a small stream located at the south end of Oakledge was sampled.

Fecal Coliform and E. Coli results are shown graphically in Appendix B at the end of this report. A log scale for the bacteriological counts was necessary because of the wide range of numbers. The last page of Appendix B shows EC versus FC plotted for all streams to see if there was any correlation between the two tests. All streams were grouped together in order to get over 30 data points, which statistics will tell you is the number of points necessary to make accurate asumptions. With a correlation coefficient of only 0.79, Burlington concurs with the EPA that there is no correlation between Fecal Coliform and E. Coli. Fecal Streptococcus will be used only as a ratio to determine the type of contamination.

A wet/dry weather scenario like the Winooski River samples was attempted, but since the watershed for each stream is different, this distinction was difficult and would have led to erroneous interpretations. For any distinct sample results mentioned, this author will point out any rainfall within two days prior to the sample being taken.

Summary of Stream Sample Results

North Beach Stream

Samples were taken from the head, middle and mouth of this stream. Results ranged from a low of 80 to a high of 13000 col/100 ml. Only 3 out of 21 samples were below the Fecal Coliform limit of 200 col/100 ml (86% above) and none were below the E. Coli limit of 77 (100 % above). Even in dry weather, this stream ran high counts. Comparing all three sample locations, the highest counts alternated fairly evenly between the head and mouth of this stream for FC, and the mouth was always higher than the others for EC. There does not appear to be a certain area causing contamination, since this data shows that the entire watershed is for the most part contributing.

Leddy Beach Streams

Eight FC samples and six EC each were run from the north and south streams at Leddy Beach. The north stream FC counts ranged from a high of 3800 colonies to a low of 20 with 5 out of 8 (63%) above the limit. North stream EC counts ranged from 50 to 1500 colonies, with 5 out of 6 (83%) above the limit.

South stream FC counts ranged from 20 to 5200 colonies, with 50% over the limit. EC ranged from <10 to >1000 with 83% over the limit of 77 col/ 100 ml.
North stream counts were higher than south stream for a given sample 5 out of 8 times which says that both streams are equally contaminated.

Oakledge South Stream

Eight FC and six EC samples were run for this stream. Fecal Coliform ranged from a low of 10 to a high of 4400 colonies with 88% over the limit. E. Coli samples ranged from 370 to 4400, and as you can see were all over the 77 col/100 ml limit. This stream appears to run contaminated all the time.

Englesby Ravine

Englesby Ravine was sampled in six locations, with some locations being done more often than others. For graphical purposes, three were designated Upper Englesby and three were called Lower Englesby. The lower section is comprised of the mouth, the ravine at Pine Street and Shelburne Road. Upper Englesby is the head of this ravine at Crescent Road and includes two ponds at Burlington Country Club which overflow into Crescent Road.
As expected, flows observed in the upper ravine area at all times were magnitudes of order less than the lower sections.
All results are summarized below, from head to mouth. The last two columns show the number of times counts were over the limit for a given parameter and how many times a particular location had the highest concentration compared to the others.

FECAL COLIFORM

Location	# sampling times	# over limit	# highest for sampling date
BCC Left Pond	7	5 (71%)	1
BCC Right Pond	7	5 (71%)	0
Crescent Road	7	7 (100%)	1
Shelburne Road	8	7 (88%)	3
Pine Street	5	5 (100%)	1
Mouth	9	6 (67%)	3

E COLI

Location	# sampling times	# over limit	# highest for sampling date
BCC Left Pond	5	4 (80%)	1
BCC Right Pond	5	3 (60%)	0
Crescent Road	4	4 (100%)	0
Shelburne Road	6	6 (88%)	2
Pine Street	5	4 (80%)	0
Mouth	8	6 (75%)	3

From the above data, one can see that this ravine like the others runs contaminated pretty much all of the time. High counts are less critical in terms of beach contamination at the head than at the mouth, since smaller flows means less of a total count of bacteria entering the lake.
The source of contamination does not originate from one particular area, rather it starts at the head and is continually added throughout the length of this ravine. Reasoning for this hypothesis is such; if bacteria was being added only at the head of this ravine, increasing flows added by travelling downward toward the lake would reduce the concentration of bacteria per 100 mls of sample. One can see from this data that the counts typically increase as they travel towards the mouth which tells us that bacterial contamination is being added at a rate greater than the addition of increased flow. Appendix D shows a graphical representation of this hypothetical situation.

FC/FS RATIO

The Fecal Coliform to Fecal Streptococcus ratio has been employed to determine whether the source of bacterial contamination stems from human or non-human origin. According to the 17th Edition of "Standard Methods for the Examination of Water and Wastewater", a FC/FS ratio <0.7 indicates animal origin, 0.7 to 4.4 is mixed human and animal, and >4.4 is human only. This version of "Standard Methods" makes it clear that this ratio is only a guide and many factors can skew the results. One of the most critical factors is the relatively short lifespan of the streptococcus bacteria outside its host compared to fecal coliform. However, it is this author's belief that if the streptococcus had indeed died off quicker than the coliform bacteria, it would only skew the ratio toward the mixed human/animal area since FC is in the denominator of the equation. The results, given at the end of this report, are summarized here.

Leddy Stream North - 7 samples taken	6 animal	1 mixed
Leddy Stream South - 6 samples	5 animal	1 mixed

North Stream Mouth - 9 samples taken	6 animal	3 mixed
North Stream Middle - 2 samples	2 animal	
North Stream Head - 5 samples	5 animal	
Englesby Ravine Mouth - 7 samples taken	4 animal	3 mixed
ER @ Shelburne - 5 samples	5 animal	
ER @ Crescent - 5 samples	4 animal	1 mixed
BCC, left pond - 5 samples	4 animal	1 mixed
BCC, right pond - 6 samples	6 animal	
Oakledge Stream - 6 samples taken	5 animal	1 mixed

One can see that at no time did the ratio indicate only human contamination. As a check, the ratio was done on primary effluents of all three treatment plants twice to see what would happen. Although the extremely high dilutions necessary to read the plates can produce large errors, the ratios ranged from a mixed of 0.8 to a definitely human ratio of 27.7.

In August of this year, a large portion of Englesby Ravine was walked to find any evidence of human contamination. No pipes were found illegally discharging into the ravine, and no evidence was found along the banks. Since the ravine and other monitored streams drain large amounts of land, both urban and wooded, this author believes that animal contamination of the nature found is a very real problem.

CSO VERSUS STREAM

This next section is an attempt to determine if high Fecal Coliform counts were perhaps caused either by a CSO or a stream. The dates of beach violations are shown below with potential causes.

Beach Location	Violation Date	Main Plant CSO	Beach Stream	Comments
North (South end)	18 June	No	Unknown	Stream samples started on 27 June
Oakledge (All)	20 June	No	Potential	Probably Englesby; 0.04 " rain fell on 19 June
Oakledge (Cove)	25 June	No	Potential	Maybe caused by Oakledge South Stream
Oakledge (All)	28 June	No	Potential	Colonies seen in Englesby

Oakledge (All)	5 July	No	Probable	0.05" rain fell on 4 July
Oakledge (South)	6 July	No	Potential	Next sampling not until 10 July
North (All)	9 July	No	Probable	Background levels seen on 10 July
North (South)	12 July	No	Probable	Background levels seen on 11 July
Oakledge (No. & So.)	16 July	No	Probable	High levels seen on same day
North (South)	23 July	No	Probable	High levels seen on same day
North (All)	24 July	Potential	Potential	CSO on 23 July plus high stream levels
Oakledge (North)	24 July	Potential	Potential	High levels in Englesby
North (All)	6 August	Potential	Probable	CSO same day; very high levels in stream
North (South)	7 August	Potential	Probable	Very high levels in stream
North (All)	9 August	No	Probable	Very high levels seen on 7 August
Oakledge (North)	13 August	No	Probable	High counts throughout Englesby
North (All)	15 August	No	Potential	Rainfall on 13 (0.5") and 15 (0.05") August
Leddy (North)	15 August	No	Potential	Rainfall on 13 (0.65") at North Plant
Oakledge (North)	15 August	No	Potential	Rain plus high levels seen in Englesby on 13th
North (All)	28 August	Potential	Potential	CSO on 27 August; no samples taken after 20 August
North (All)	29 August	Potential	Potential	CSO on 28 August
North	7 Sept.	Unknown	Unknown	Data not available

This information shows that the streams feeding into our beaches are much more of a threat than a CSO from the Main Treatment Plant. Therefore, combined sewer separation and stormwater treatment may reduce but will not eliminate the number of beach closings due to bacteriological contamination. The only options available to reduce loadings on the beaches caused by contaminated streams are briefy outlined below:

Option	Advantage	Disadvantage
Source elimination or reduction	Ideally the best way to clean up streams	Nearly impossible since source does not originate from a particular area. Non-enforceable
Detention Ponds	Contaminated stream flow not allowed into Lake	Not possible on all streams because many are too large
Stream Disinfection	Bacteriological kill achieved over wide flow range	Disinfection by-products released if chlorine used. Continual O & M costs

FECAL COLIFORM VERSUS E. COLI

This last section deals with the use of one bacteriological test over another for next year's beach/swim season and beyond. Fecal Coliform is still widely used for recreational waters, and in fact will continue to be used by the State of Vermont Health Department. However, a 1984 EPA report titled "Health Effects Criteria for Fresh Recreational Waters" could not find a correlation between FC counts and gastrointestinal illnesses in exposed swimmers. Although this report is the only one known to us, it is quite thorough in its procedure. EPA did find a correlation between illnesses and concentrations of both E. Coli and Fecal Streptococcus. We have successfully tested samples for streptococcus and the procedure is easier than E. Coli, however its 48 hour incubation period makes it unuseable for beach testing.

Our next choice is between using FC or EC as a standard, and at what concentration is considered an acceptable risk. Let's review the current standards and use them in conjunction with our own data to make this determination.

The current wastewater standard for Fecal Coliform is 200 colonies per 100 mls of sample. This standard is derived from the Total Coliform limit, which was arbitrarily set by the California Bureau of Sanitary Engineering in 1943 at 1000 col/100ml. The FC limit was then adopted after research in the mid 1960's showed that Fecal Coliform averaged roughly 20% of Total Coliform in the Ohio River. Therefore, neither of these standards have any epidemiological basis.

Based upon the above mentioned report, EPA has asked States to utilize E. Coli as the standard for wastewater effluent. They gave States the flexibility to

set the limit, however they could not exceed 125 col/100 ml, which translates to a level of risk for 9 out of 1000 swimmers (0.9%) to potentially contract gastrointestinal illness by swimming in polluted waters. The State of Vermont has adopted a wastewater effluent limit of 77 col/100 ml which translates to 6 infected swimmers out of 1000 (0.6%). Appendix C contains the graph taken from this EPA report. Burlington does not need to adopt the State's effluent limit for recreational waters, but can make their own choice about an acceptable level of risk. A comparison of the beach violations using Fecal Coliform, E. Coli at 77 col/100 ml and E. Coli at 125 col/100 ml are summarized below:

Violation Comparisons

Beach Location	% violation Fecal Coliform	% violation E. Coli @ 77	% violation E. Coli @ 125
North Beach North	17%	44%	33%
North Beach South	29%	44%	22%
Leddy Beach North	0%	43%	14%
Leddy Beach South	5%	57%	29%
Oakledge North	30%	50%	50%
Oakledge South	22%	25%	25%
Oakledge Cove	17%	25%	0%

It is this author's belief that E. Coli be considered as the method of choice because of the epidemiological evidence presented by the EPA. In addition, I also think that the recreational water limit in Burlington be 125 colonies per 100 mls of sample because the level of risk at this concentration (0.9% versus 0.6%) is, in my opinion, acceptable and would not cause unnecessary beach closings. The wastewater limit of 77 colonies is acceptable and achievable for a water that is disinfected, but this limit at the beaches would result in overly conservative closings. Unfortunately, too few samples were taken this summer to immediately adopt this policy. Therefore, it is recommended that a decision be made after next summer's data is reviewed. Next summer's goal would be to run Fecal Coliform and E. Coli on the same samples, using the FC results as a governing factor.

SUMMARY OF OBJECTIVES

The objectives outlined on pages 1 and 2 of this report are summarized below:

- Are high bacteriological results on the Winooski River being caused by other sources or Burlington's wastewater plants.
  High Fecal Coliform counts on the Winooski River result from stormwater runoff during rain events and are not caused by Burlington's treatment plants.

- Is the contamination of streams discharging into the vicinity of Burlington's beaches coming from human or non-human origin.
  Evidence shows that the contamination of streams feeding into Burlington's beaches are caused with high certainty by animal sources.

- Can we determine the approximate location of stream contamination.
  Based upon the information presented, bacteriological contamination is added throughout the drainage area of these streams. No specific locations can be identified.

- Are high beach counts and subsequent closings the result of these streams, combined sewer overflows or a combination of both.
  Most of the beach closings appeared to be caused by streams flowing into them rather than CSO's. Out of all the beaches, North Beach appears to be the most sensitive to a potential of CSO's based on its geographical location. CSO locations at the time - Main Plant, Maple Street, College Street

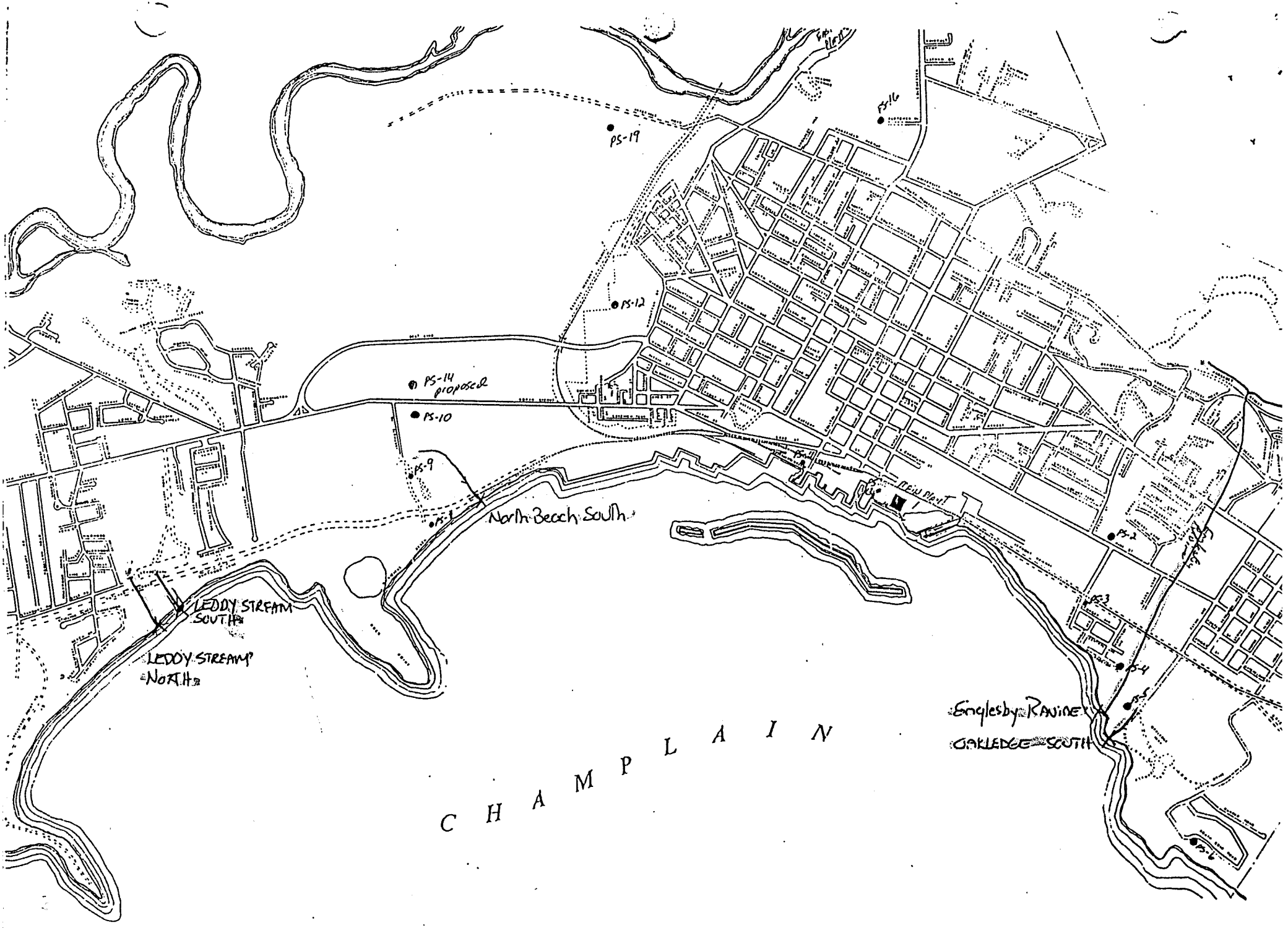
- Is E. Coli or Fecal Coliform the most accurate and repeatable bacteriological test to perform.
  E. Coli is the best method based upon scientific evidence.

- Should we use the State of Vermont's E. Coli limit for wastewater effluent on beach samples or should we adopt a different limit based on the above mentioned EPA report.
  It is recommended that we adopt a limit of 125 colonies/100 mls of sample for recreational waters after sufficient data from next year's beach/swim season is reviewed.

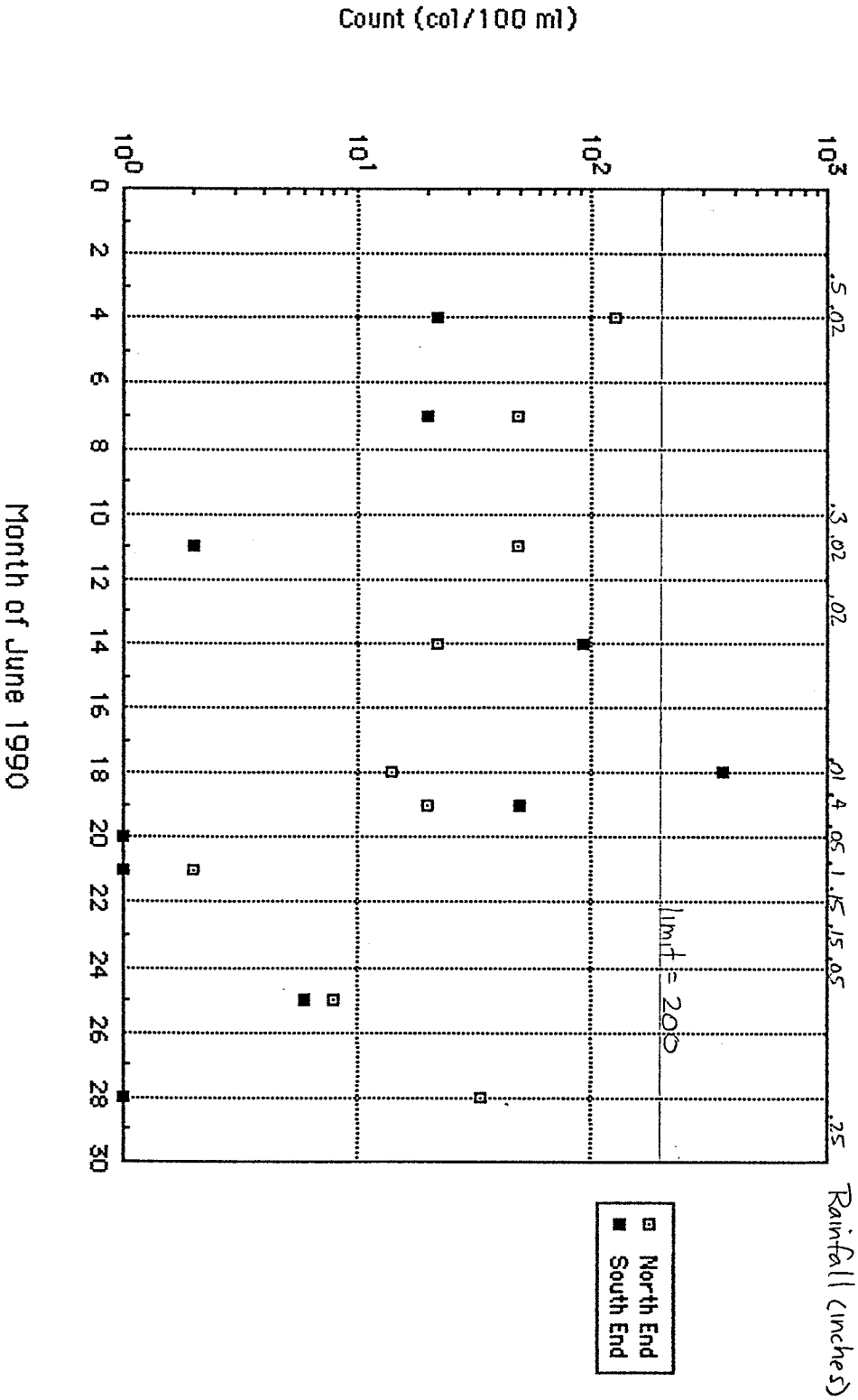
Many thanks to Burlington Parks Department for collecting beach samples, and especially to DPW's Wastewater Division, both full-time and part-time employees, who not only collected but also ran and read most of the samples done this summer.

Stephen T. Roy
Process Engineer

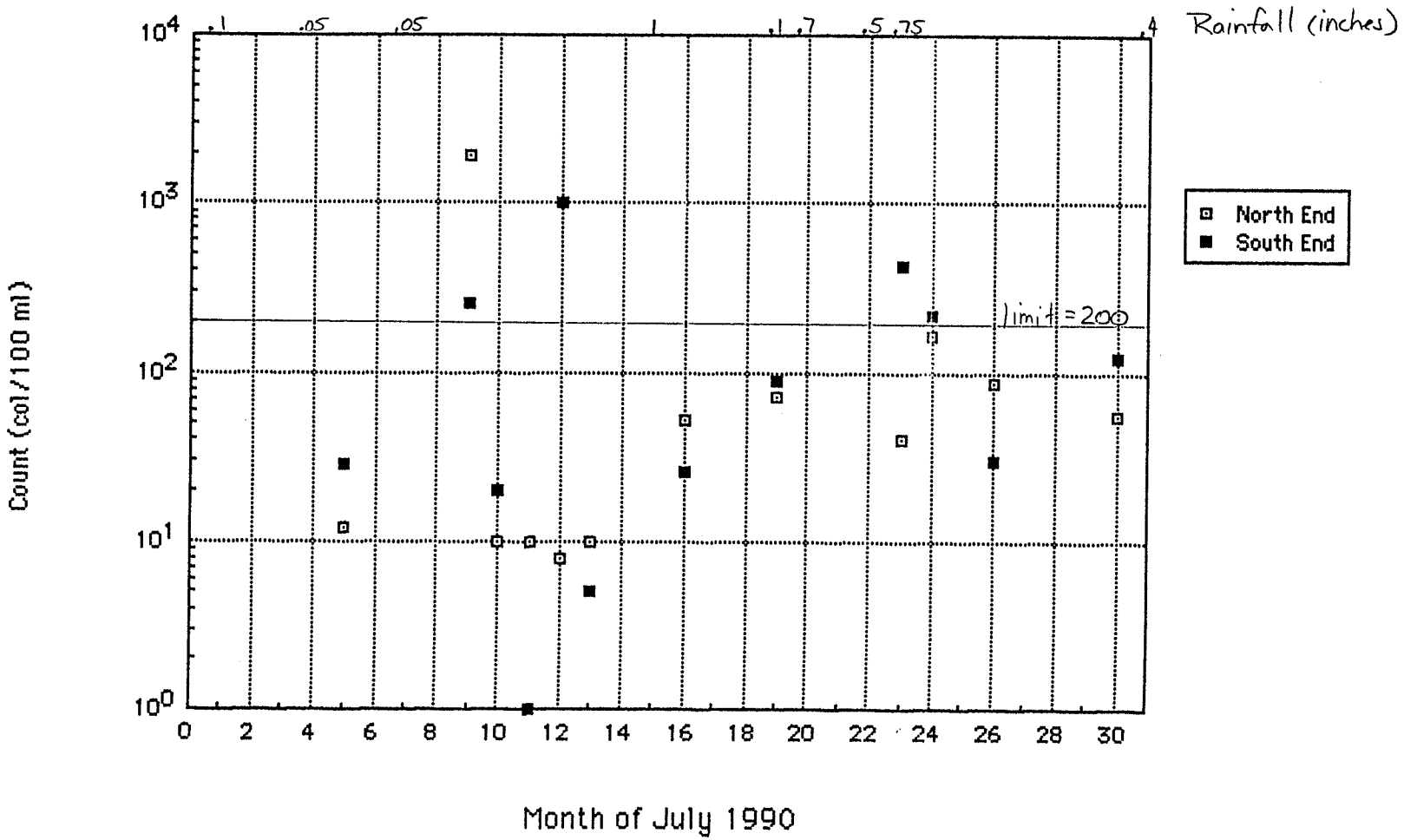
APPENDIX A


PS-19
PS-16
PS-12
PS-14
proposed
PS-10
PS-9
PS-1
North Beach South
LEDDY STREAM
SOUTH
LEDDY STREAM
NORTH
PS-2
PS-3
PS-4
PS-5
Englesby RAVINE
OAKLEDGE SOUTH
PS-6
CHAMPLAIN

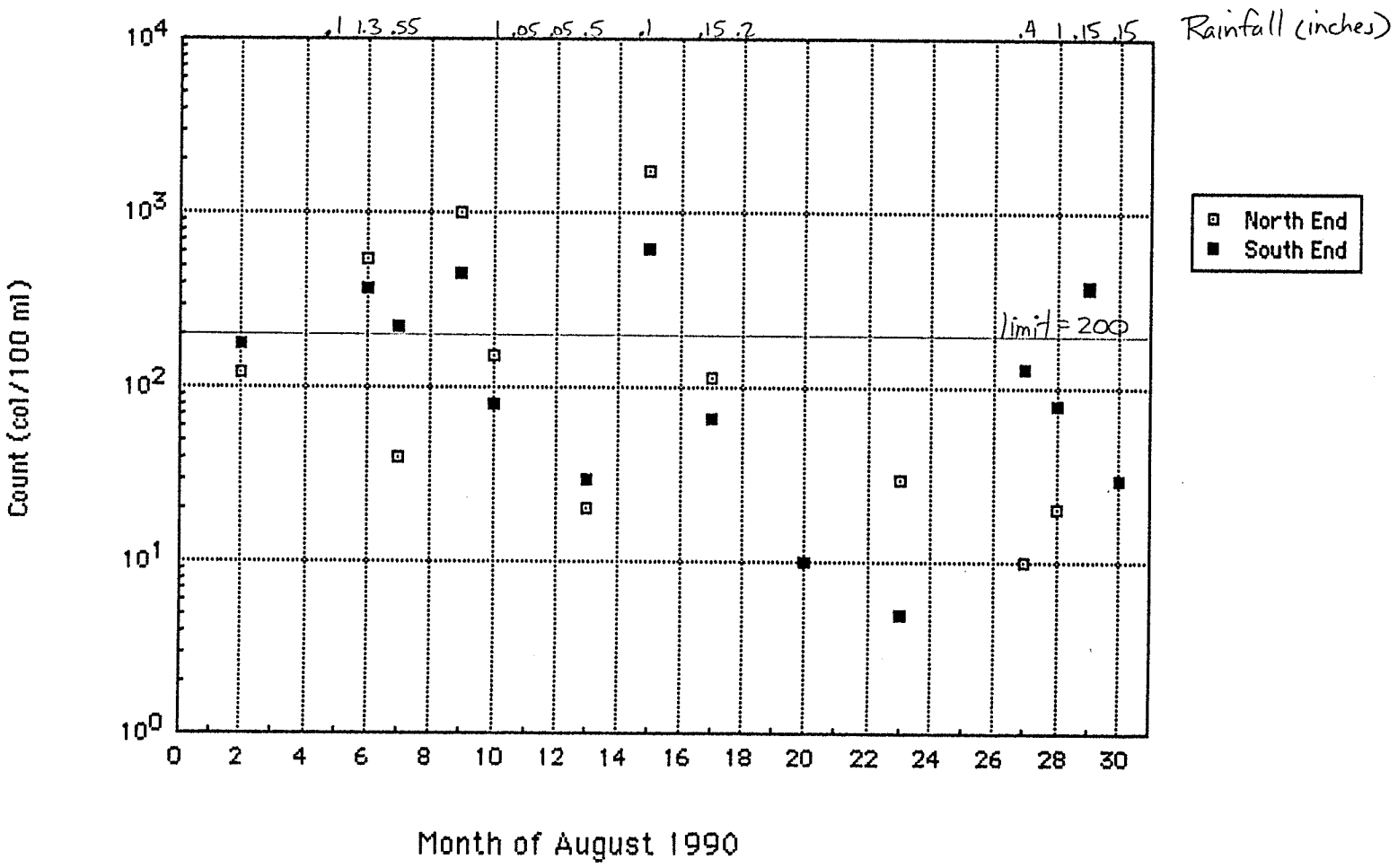
APPENDIX A


FECAL COLIFORM RESULTS FOR NORTH BEACH
Count (col/100 ml)
10^3
10^2
10^1
10^0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Month of June 1990
.5 .02 .3 .02 .02 .01 .4 .05 .1 .15 .15 .05 .25
Rainfall (inches)
limit = 200
North End
South End

FECAL COLIFORM RESULTS FOR NORTH BEACH



FECAL COLIFORM RESULTS FOR NORTH BEACH



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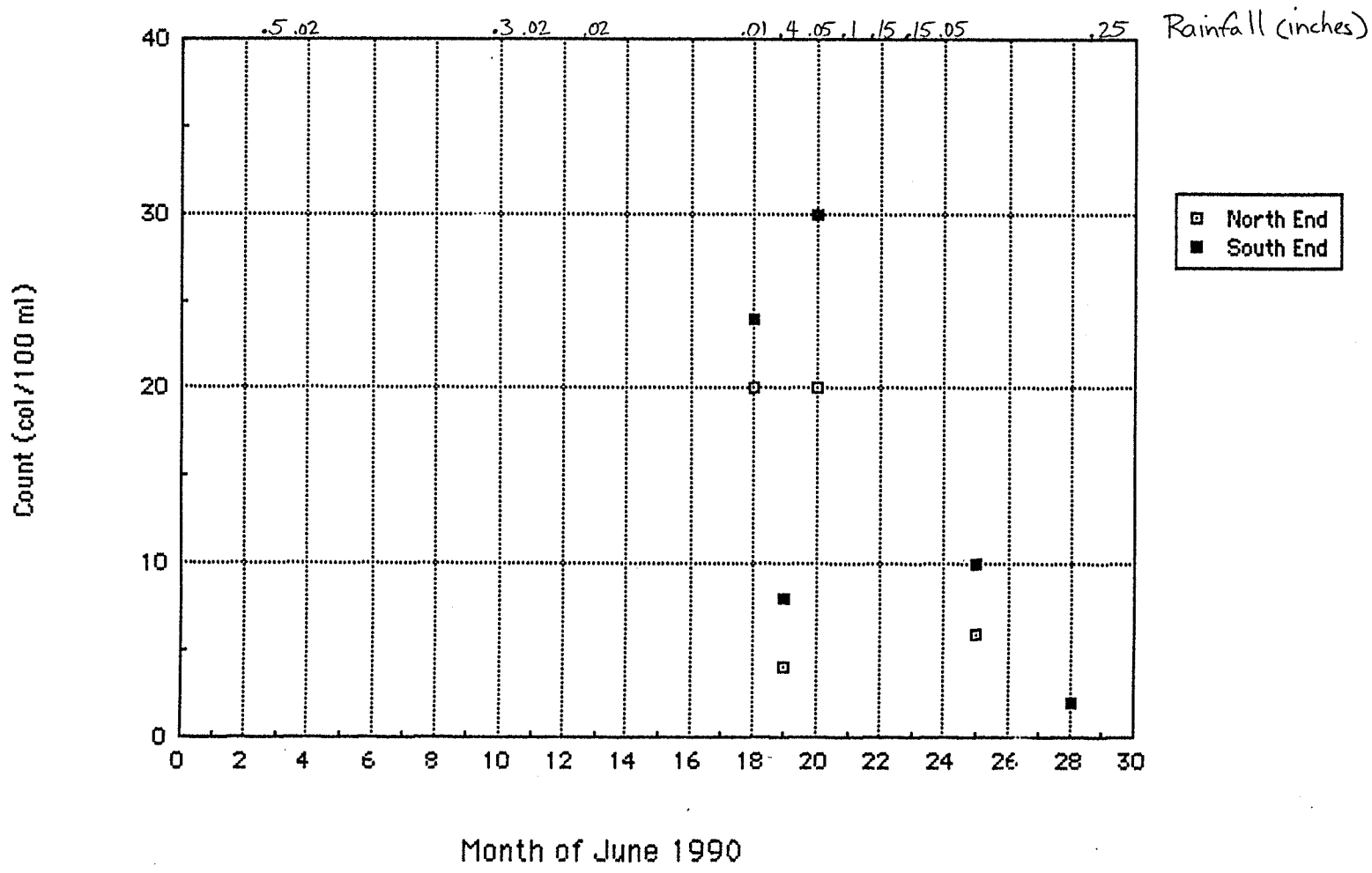

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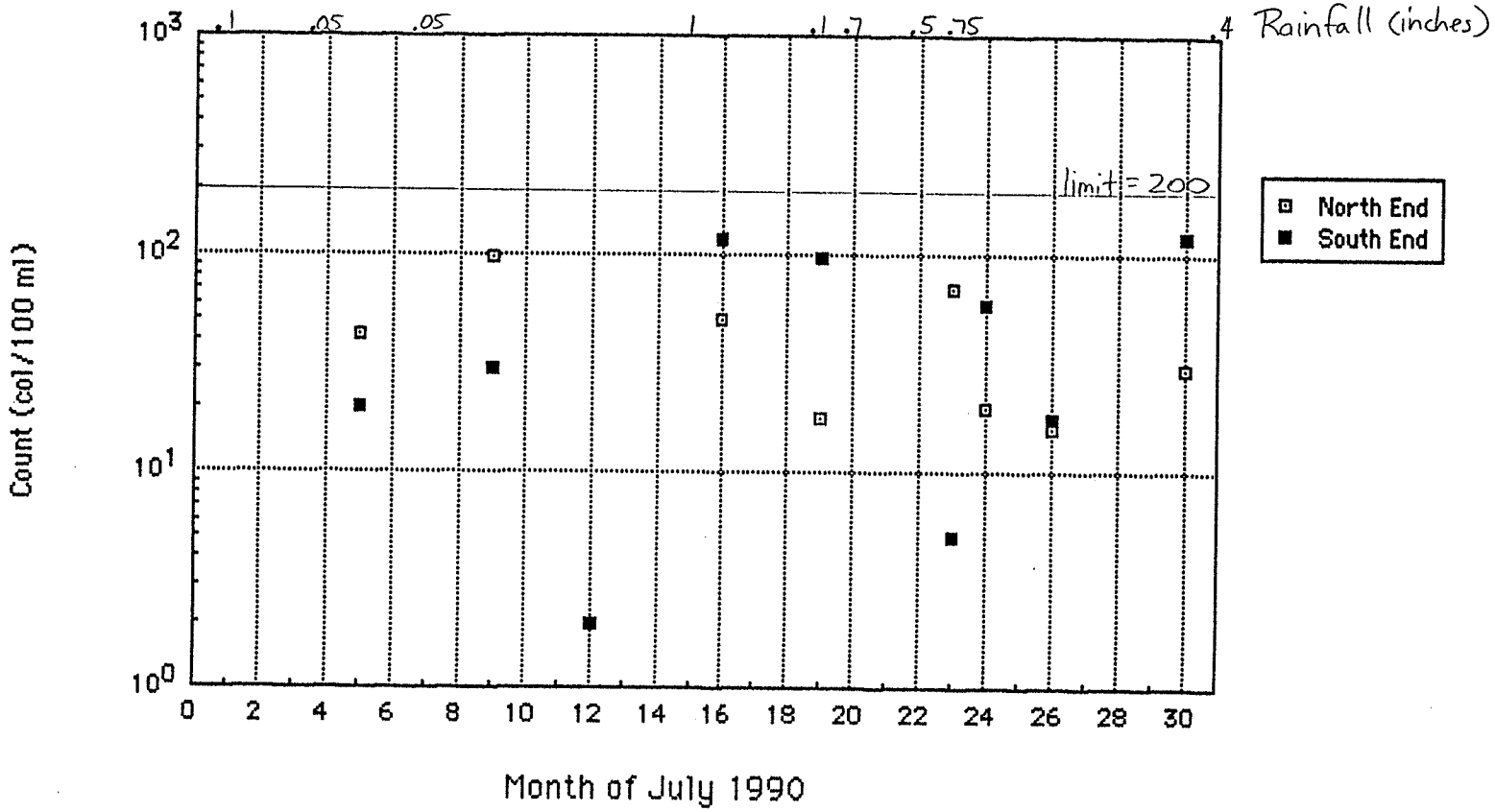
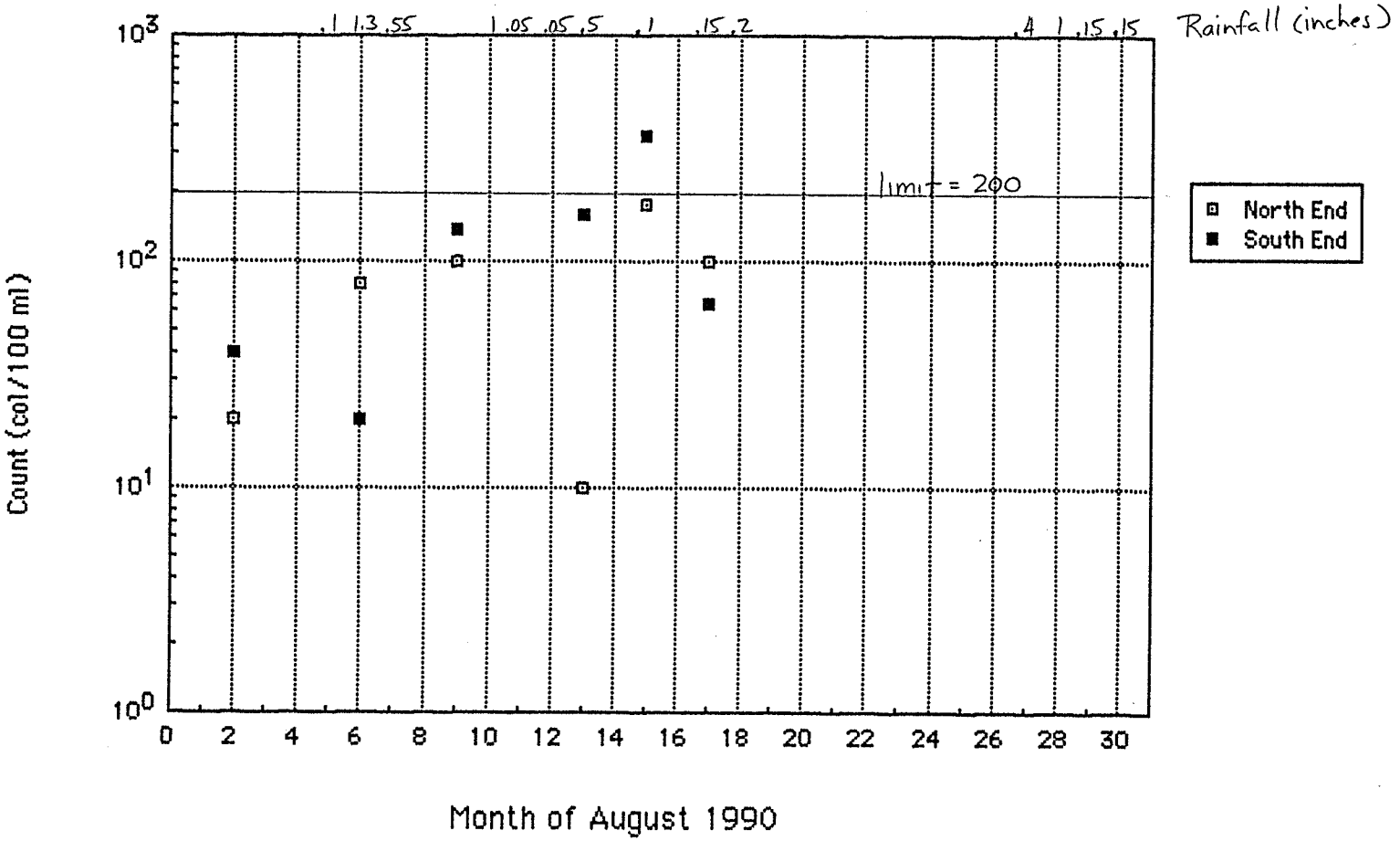
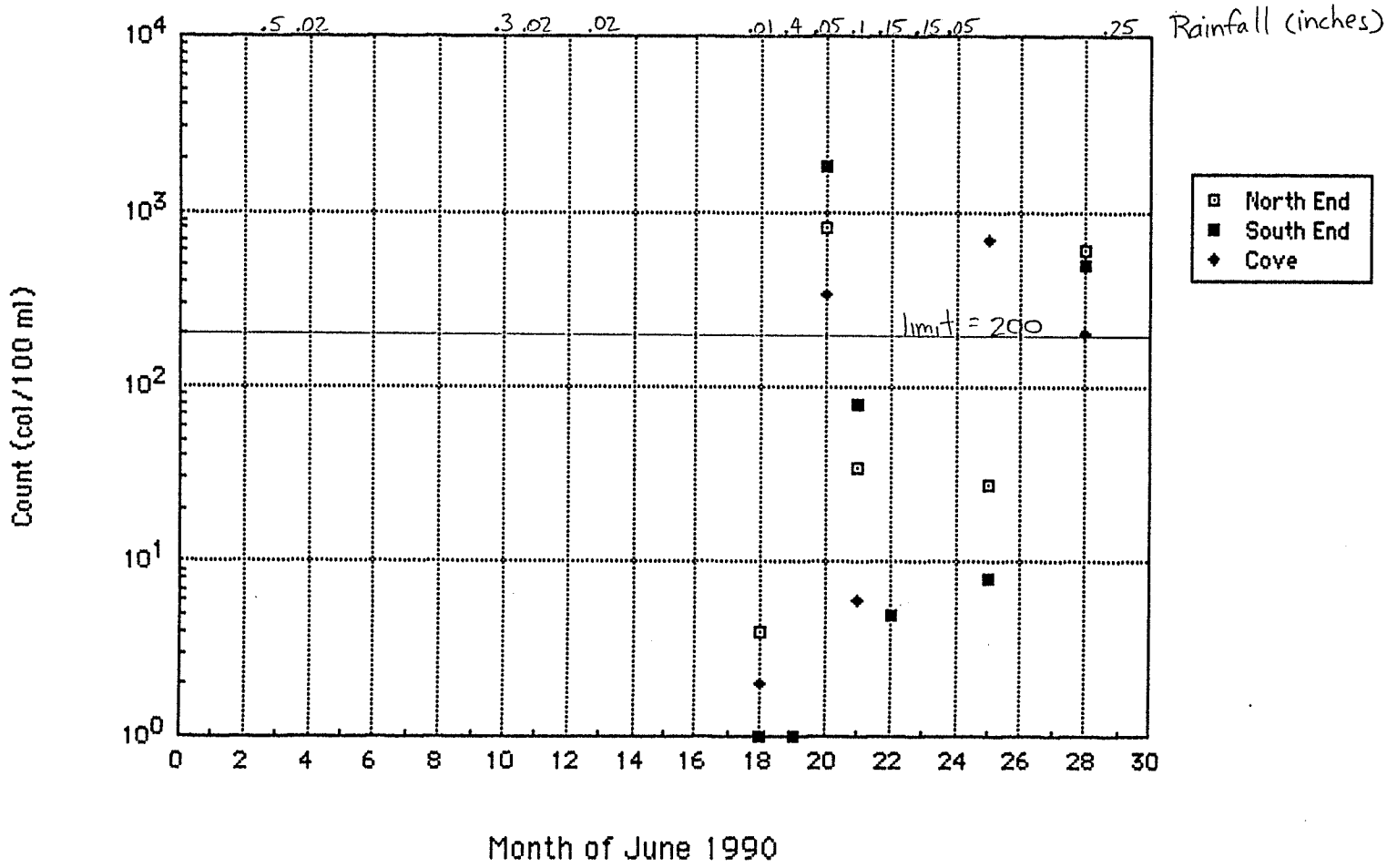


FECAL COLIFORM RESULTS FOR LEDDY BEACH



FECAL COLIFORM RESULTS FOR OAKLEDGE



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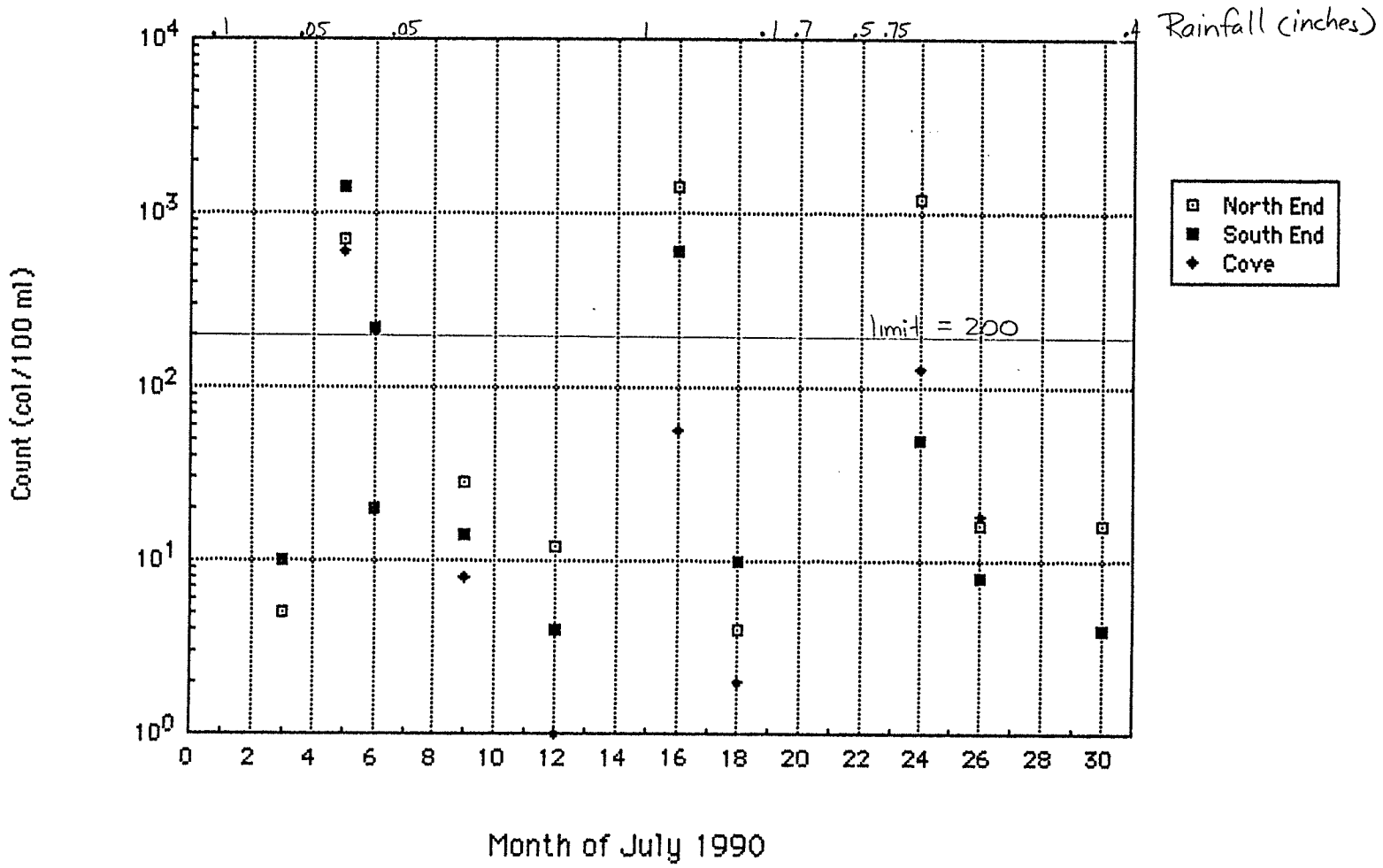

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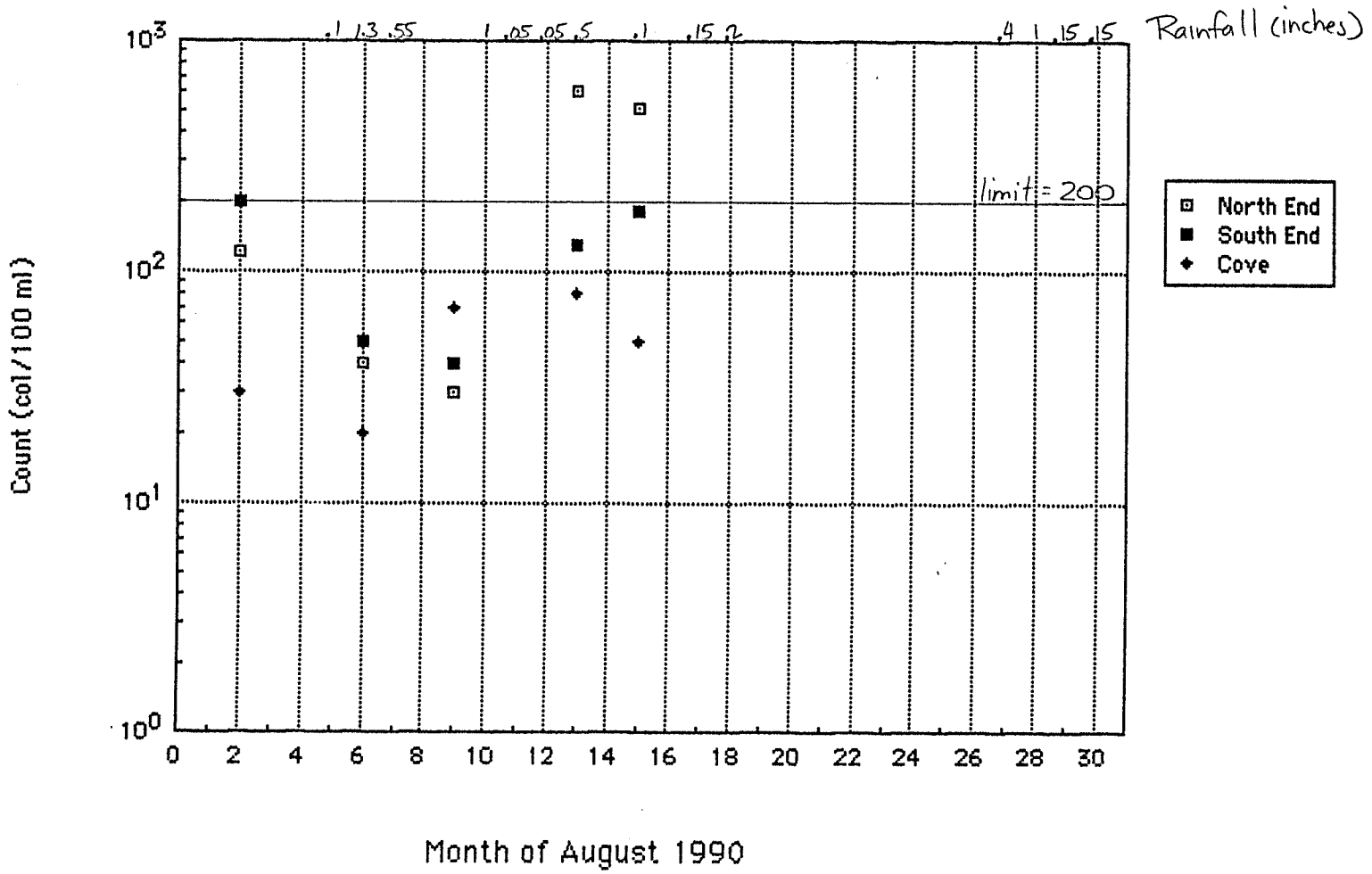
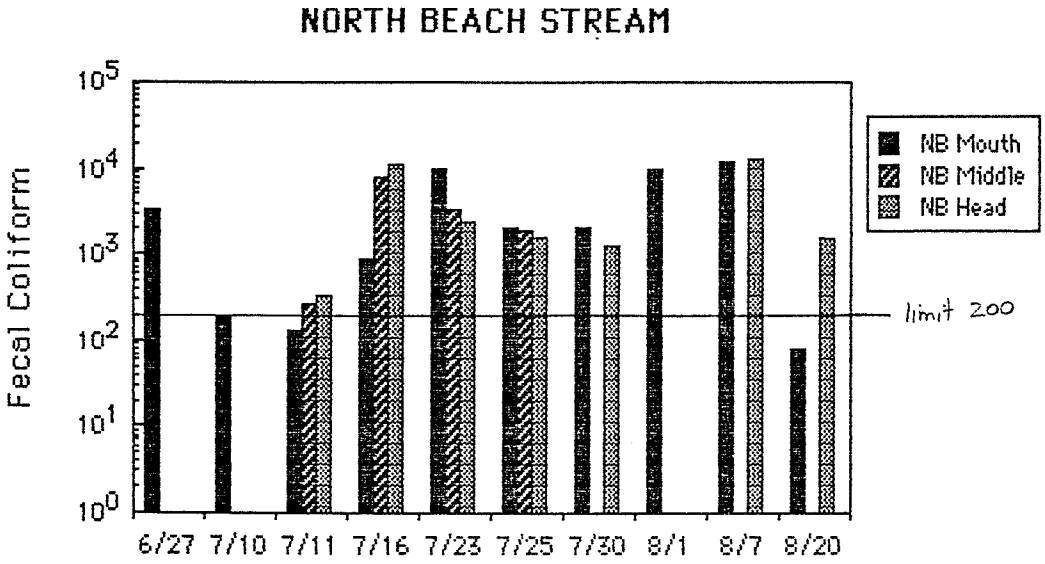
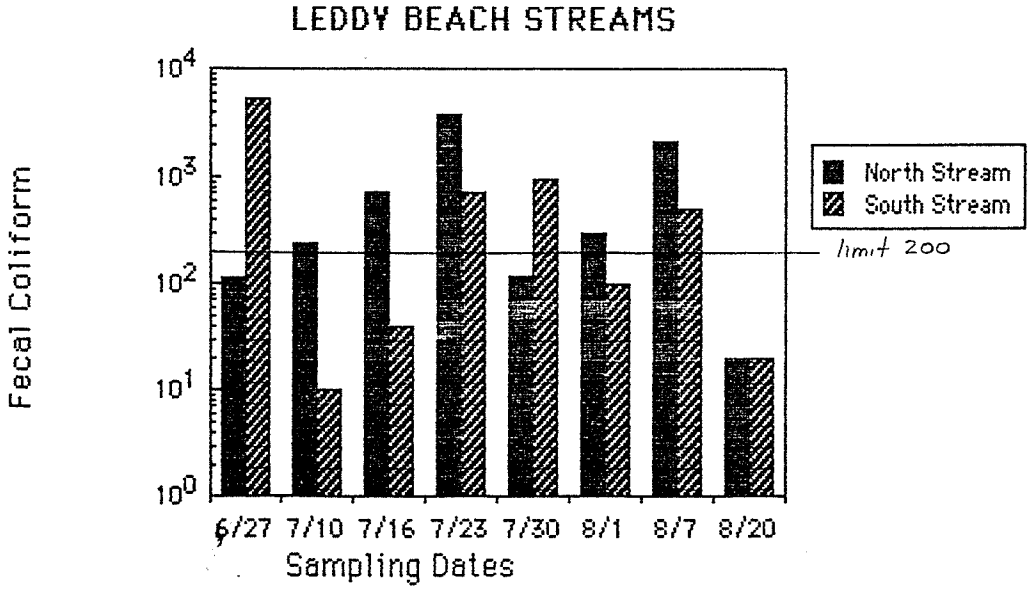
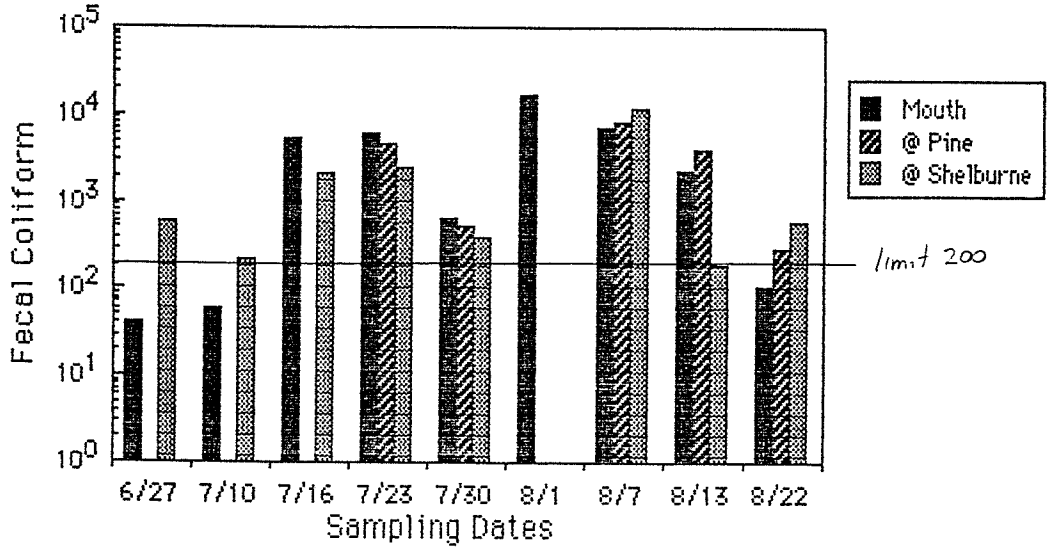


APPENDIX B

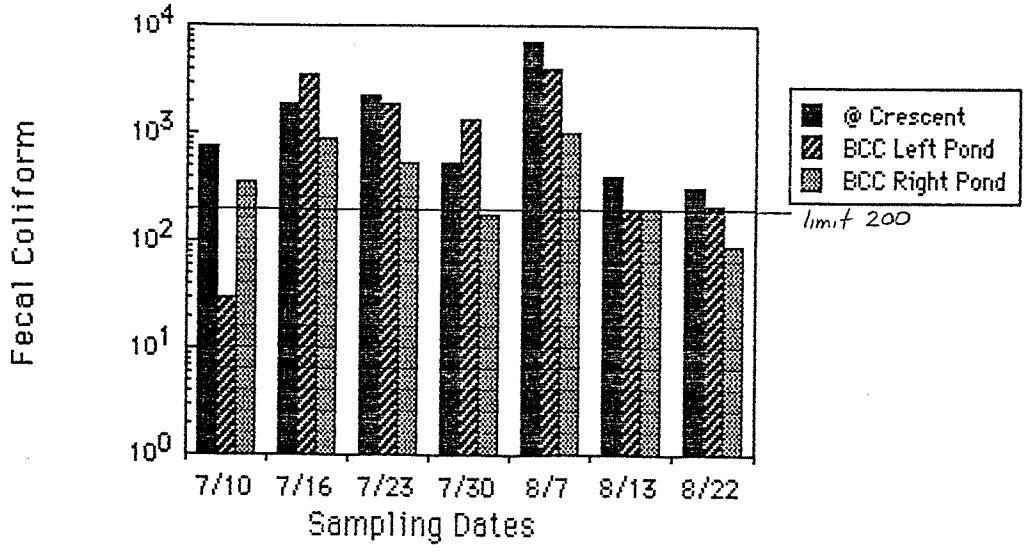

NORTH BEACH STREAM
Fecal Coliform
10^5
10^4
10^3
10^2
10^1
10^0
6/27 7/10 7/11 7/16 7/23 7/25 7/30 8/1 8/7 8/20
NB Mouth
NB Middle
NB Head
limit 200


LEDDY BEACH STREAMS
Fecal Coliform
10^4
10^3
10^2
10^1
10^0
6/27 7/10 7/16 7/23 7/30 8/1 8/7 8/20
Sampling Dates
North Stream
South Stream
limit 200

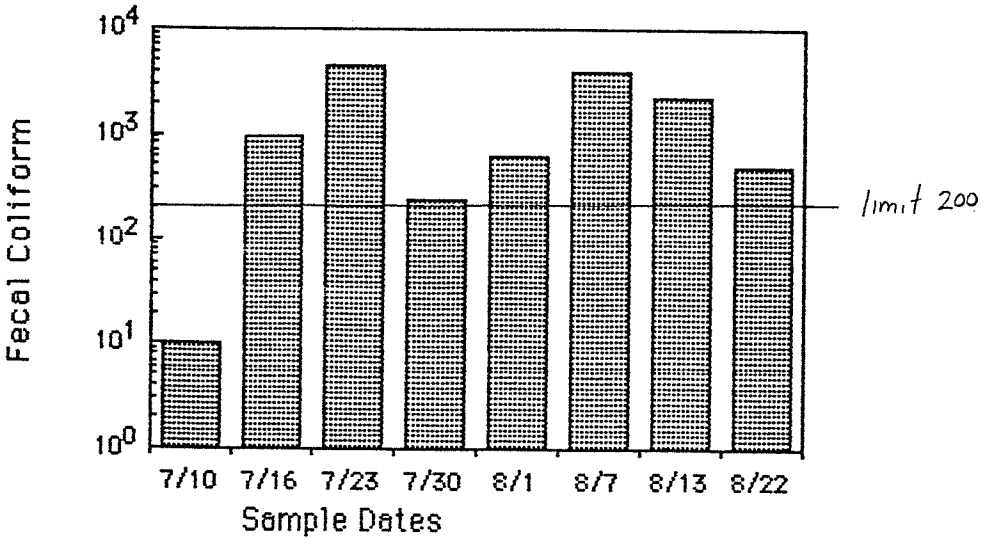
LOWER ENGLESBY RAVINE



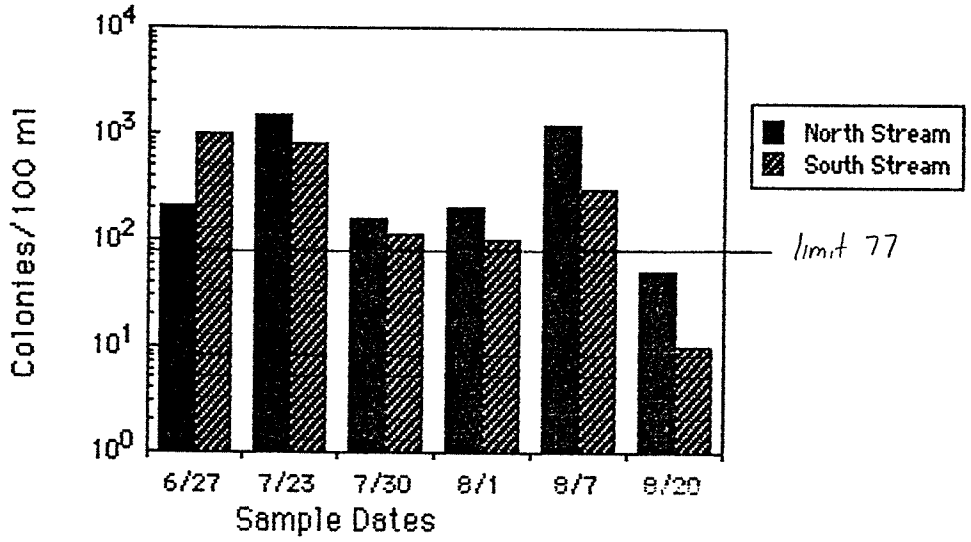
UPPER ENGLESBY RAVINE



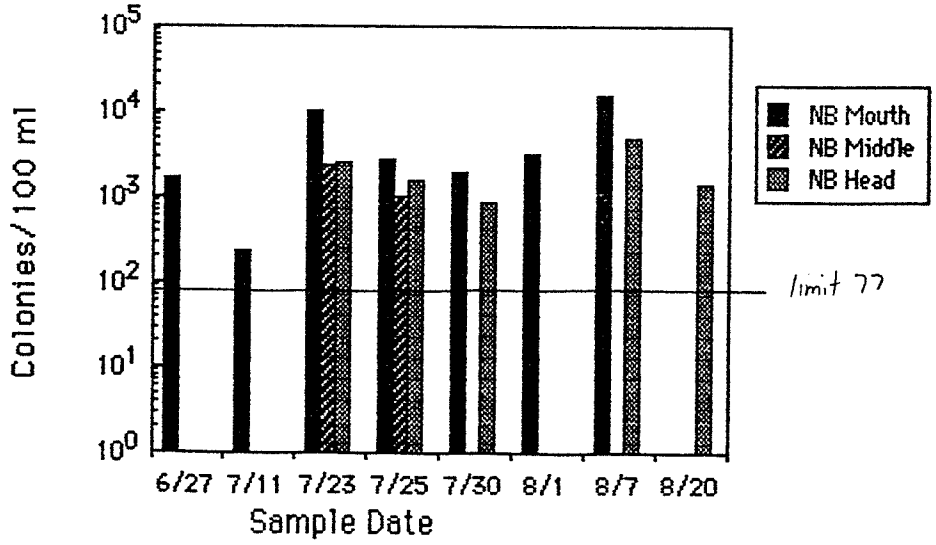
OAKLEDGE SOUTH STREAM



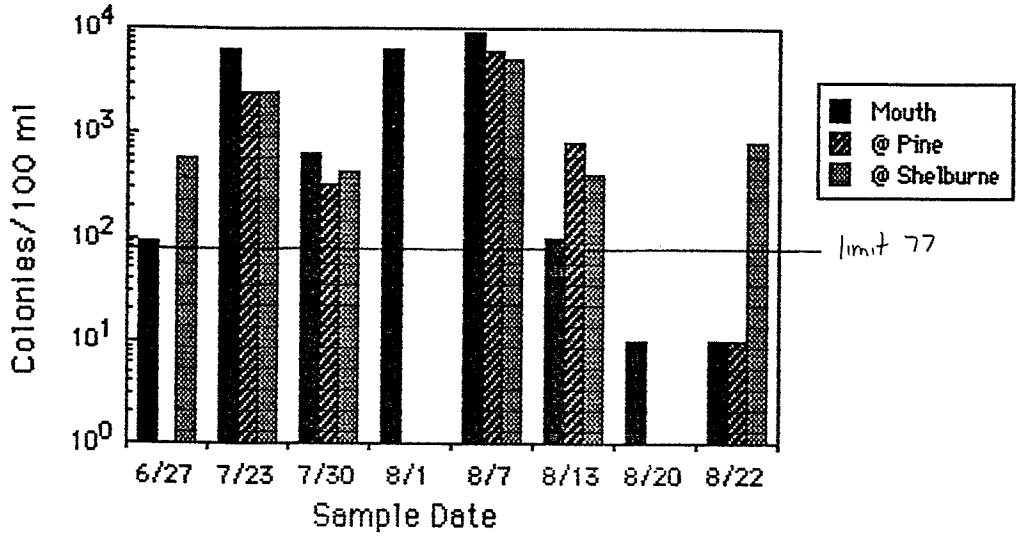
LEDDY BEACH STREAMS (E. COLI)



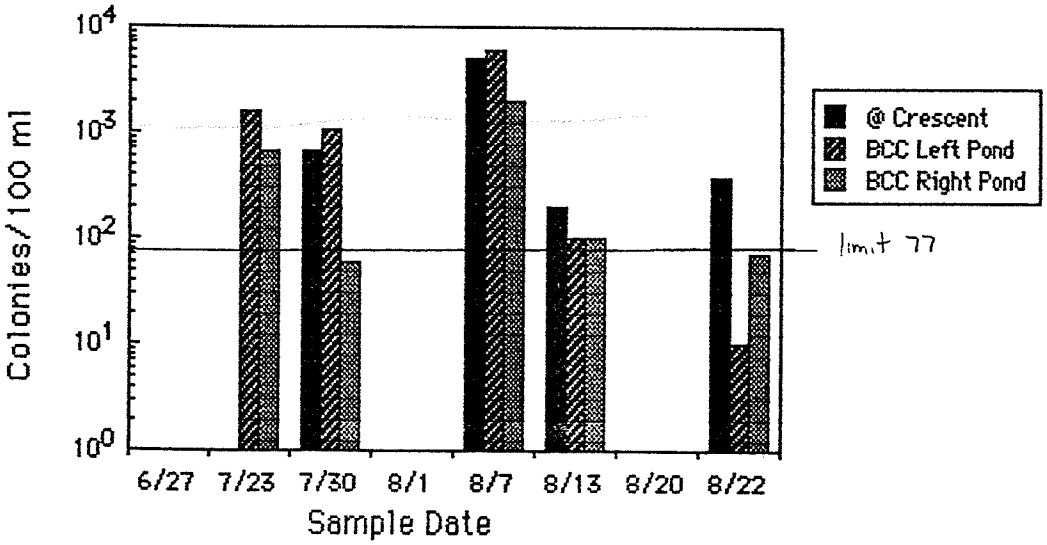
NORTH BEACH STREAM (E. COLI)



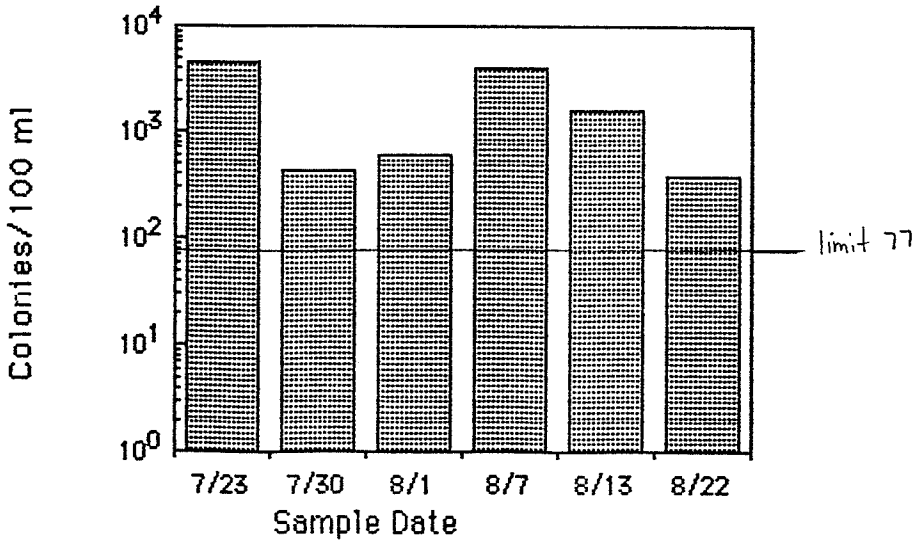
LOWER ENGLESBY RAVINE (E. COLI)



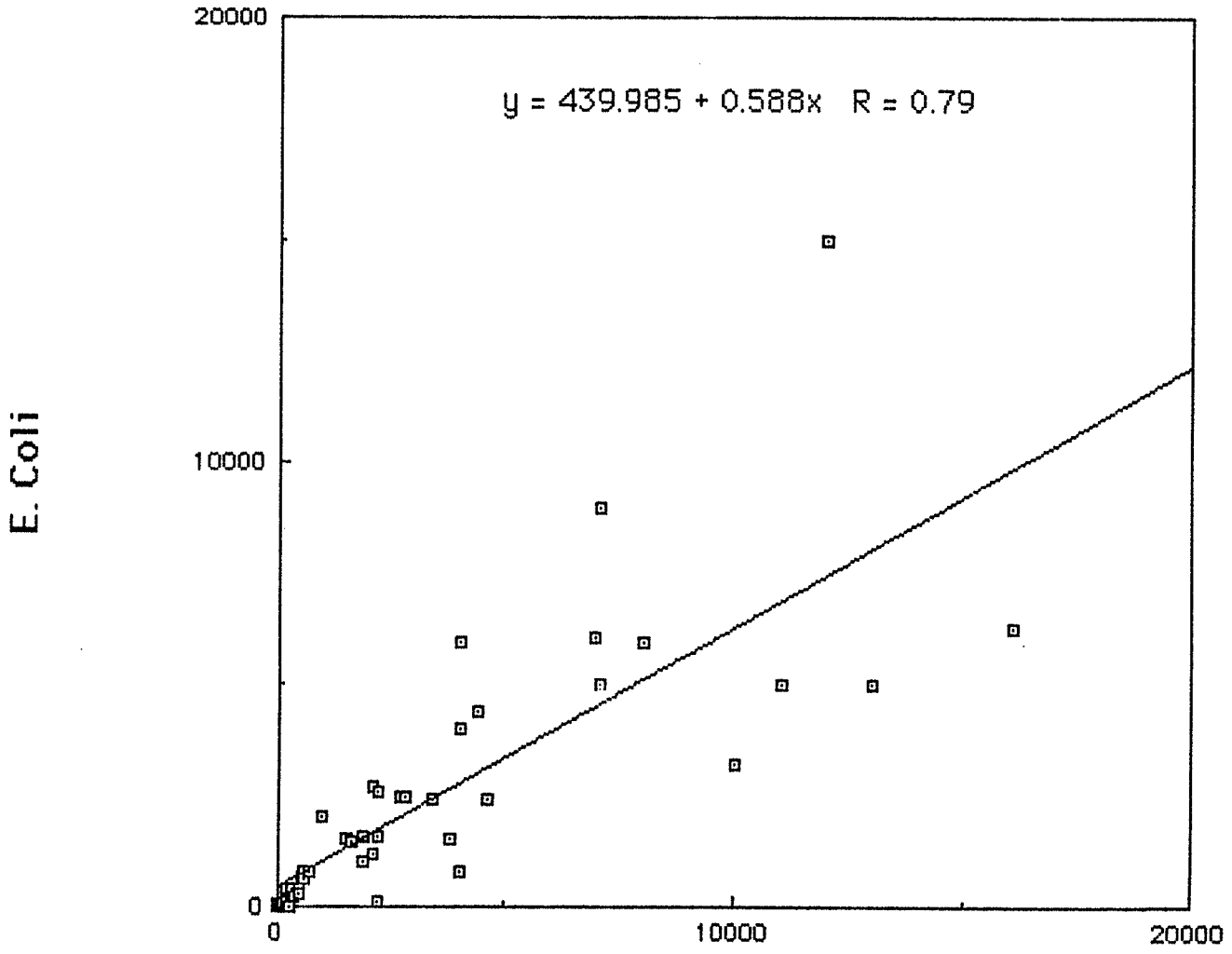
UPPER ENGLESBY RAVINE (E. COLI)



OAKLEDGE SOUTH STREAM (E. COLI)



FC/EC CORRELATION - ALL STREAMS



46 Data Points Each

APPENDIX C

APPENDIX C

Taken from "Health Effects Criteria for Fresh Recreational Waters", Environmental Protection Agency, 1984.

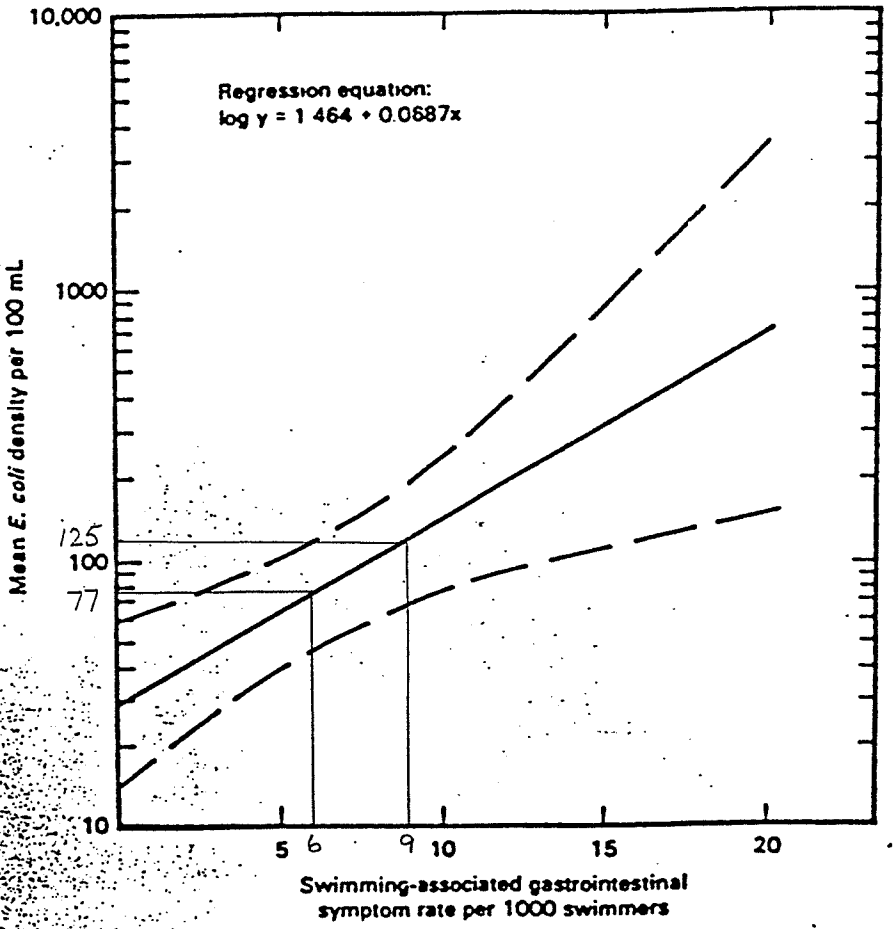
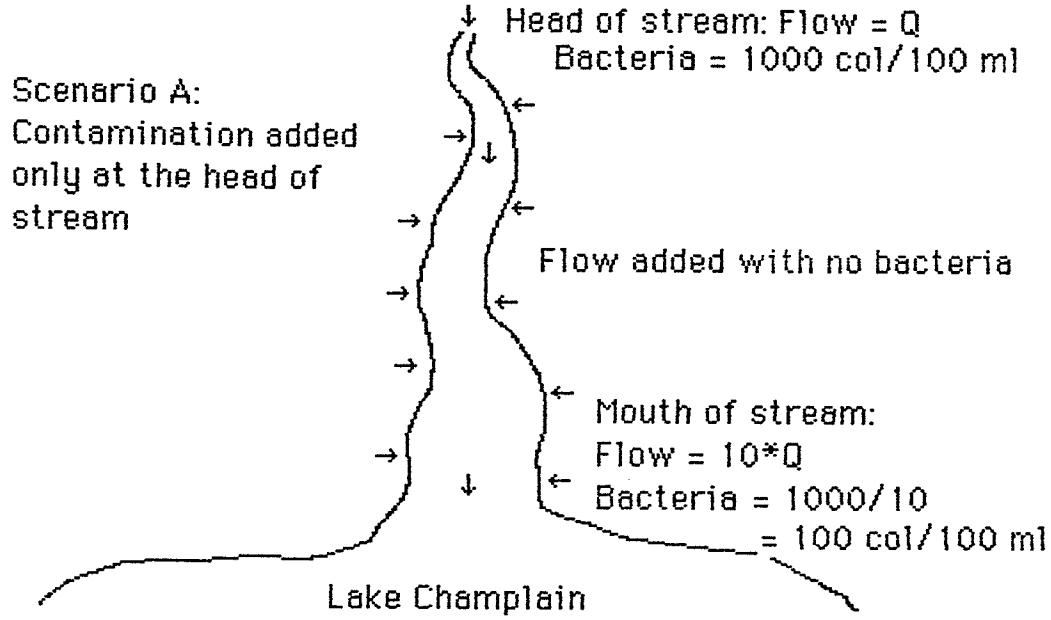
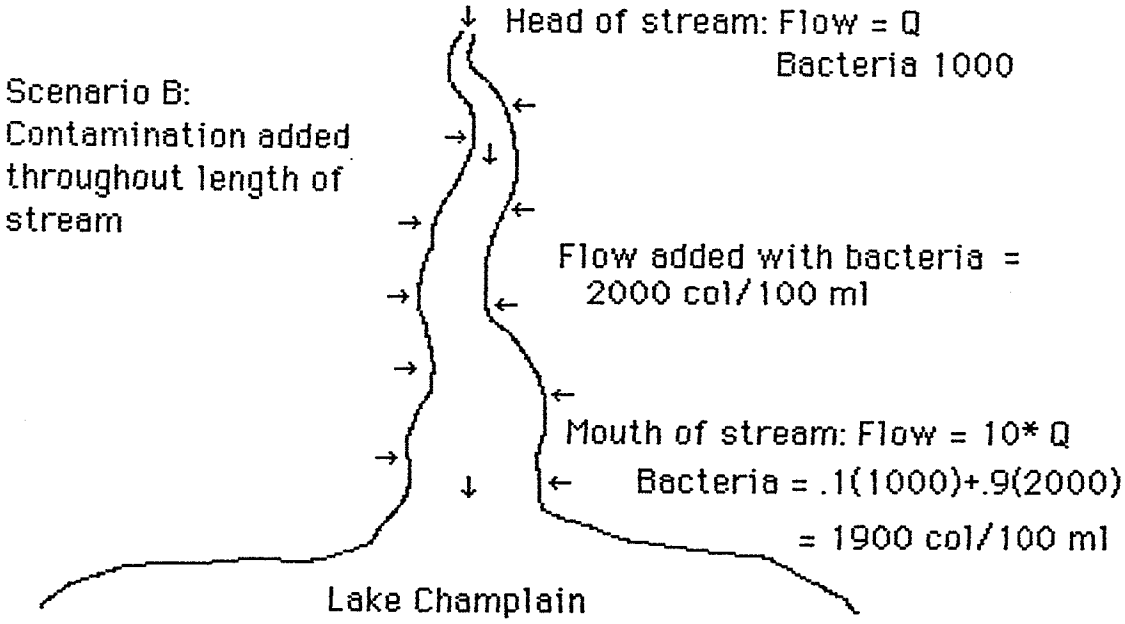


Figure 6. Criterion for estimating the geometric mean *E. coli* density per 100 mL from an acceptable risk level of swimming-associated gastrointestinal illness.

APPENDIX D


Scenario A:
Contamination added only at the head of stream
Head of stream: Flow = Q
Bacteria = 1000 col/100 ml
Flow added with no bacteria
Mouth of stream:
Flow = 10*Q
Bacteria = 1000/10
= 100 col/100 ml
Lake Champlain


Scenario B:
Contamination added throughout length of stream
Head of stream: Flow = Q
Bacteria 1000
Flow added with bacteria = 2000 col/100 ml
Mouth of stream: Flow = 10* Q
Bacteria = .1(1000)+.9(2000)
= 1900 col/100 ml
Lake Champlain

RAW DATA

* Fecal *

"TESTING" BURLINGTON PUBLIC WORKS – WASTEWATER DIVISION Sheet # 90-1

STREAM: SAMPLES

	SAMPLE DATE BY	LEDDY BEACH NORTH	LEDDY BEACH SOUTH (Northern)	NORTH BEACH MOUTH (Main Pond)	NORTH BEACH MIDDLE	NORTH BEACH HEAD	Mouth	Shelburne	ENGLESBY RAVINE Crescent	South Prospect	L. Golf Course R.	OAK ledge South
Sample	6/27 S.C. T.G.	110	5,200	3,400			40	580		350		
Sample:	7/10 S.F.	240	<10	180			60	230	750		30 360	10
Sample:	7/11 S.F.			130	270	330						
Sample:	7/16 S.F.	710	40	900	7,600	11,500	5,400	2,100	1,890		3,500 / 890	900
Sample:	7.23 S.F.	3,800	720	TNTC >10,000	3,400	2,400	6,100	2,500	2,200	Pine Street 4,600	1900 / 520	4,400
Sample:	7.25 S.F.			2,100	1,900	1500						
Sample:	7.30	120	930	2110		1220	660	380	530	530	1300 / 150	240
Raining Sample:	8.1	300	<100	10,000			16,100					600
Raining Sample:	8.7	2,100	500	12,000		13,000	7000	11,000	7000	8,000	4000 / 1000	4000
rain Sample:	8.13						2200	200	400	1000	200 / 300	2200
Sample:	8.20	20	20	80		1,600						
Sample:	8.22						110	540	320	290	210 / 90	470
Sample:												

Fecal

"TESTING"

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION
SWIM BEACH SAMPLES

Sheet # 1

	SAMPLE DATE	SAMPLED BY	LAB	NORTH BEACH NORTH	NORTH BEACH SOUTH	LEDDY BEACH NORTH	LEDDY BEACH SOUTH	OAKLEDGE NORTH	OAKLEDGE SOUTH	COVE
Sample:	5/31/90	Parks		170	14					
Sample:	6/4/90	Parks		126	22					
Sample:	6/7/90	Parks		48	20					
Sample:	6/11/90	Parks		48	2					
Sample:	6/14/90	Parks		22	92					
Sample:	6/18/90	Parks		14	(360)	20	24	4	<1	2
Sample:	6/19/90	Parks		20	50	4	8	<1	<1	<1
Sample:	6/20/90	Parks		<1	<1	20	30	(800)	(1800)	(340)
Sample:	6/21/90	Parks	AM	2	<1			64	140	76
Sample:	6/21/90	Parks	PM					34	80	6
Sample:	6/22/90	Parks	AM					<10	<10	<10
Sample:	6/22/90	Parks	PM	Lab accident	Lab accident	Lab accident	Lab accident	Lab accident	Lab accident	Lab accident

"TESTING" BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION Sheet # 2
SWIM BEACH SAMPLES

	SAMPLE DATE	SAMPLED BY	LAB	NORTH BEACH NORTH	NORTH BEACH SOUTH	LEDDY BEACH NORTH	LEDDY BEACH SOUTH	OAKLEDGE NORTH	OAKLEDGE SOUTH	COVE
Sample:	6/28/90	Parks		8	6	6	10	28	8	(700)
Sample:	6/28/90	Parks		34	<1	2	2	(600)	(500)	(206)
Sample:	7/3/90	Parks						<10	10	10
Sample:	7/5/90	Parks		<12	28	43	20	(700)	(1400)	(600)
Sample:	7/6/90	Parks						20	(220)	20
Sample:	7/9/90	Parks		(1900)	(254)	98	30	28	14	8
Sample:	7/10/90	Parks		10	20					
Sample:	7/11/90	Parks		10	<1					
Sample:	7/12/90	Parks		8	(1000)	2	2	12	4	<1
Sample:	7/13/90	Parks		10	<10					
Sample:	7/16/90	Parks		52	26	50	118	(1400)	(600)	56
Sample:	7/18/90	Parks						4	10	2

"TESTING"

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION
SWIM BEACH SAMPLES

Sheet # 3

	SAMPLE DATE	SAMPLED BY	LAB	NORTH BEACH NORTH	NORTH BEACH SOUTH	LEDDY BEACH NORTH	LEDDY BEACH SOUTH	OAKLEDGE NORTH	OAKLEDGE SOUTH	COVE
Sample:	7/19/90	Parks		72	90	18	98			
Sample:	7/23/90	Parks		40	420	70	<10			
Sample:	7/24/90	Parks	AM	240	360	20	20			
Sample:	7/24/90	Parks	PM	90	70	20	100	1200	<100	130
Sample:	7.26.90	PARKS	AM	86	30	16	18	16	8	18
Sample:	7.30.90	PARKS	AM	56	124	30	122	16	4	4
Sample:	8.2.90	PARKS	AM	120	180	20	40	120	200	30
Sample:	8.6.90	PARKS	AM	540	370	80	20	40	50	20
Sample:	8.7.90	PARKS	PM	40	220					
Sample:	8.9.90	PARKS	AM	1,000	450	100	140	30	40	70
Sample:	8.10.90	PARKS	PM	150	80					
Sample:	8.13.90	PARKS	AM	20	20	10	160	610	130	80

"TESTING"

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION
SWIM BEACH SAMPLES

Sheet # 4

	SAMPLE DATE	SAMPLED BY	LAB	NORTH BEACH NORTH	NORTH BEACH SOUTH	LEDDY BEACH NORTH	LEDDY BEACH SOUTH	OAKLEDGE NORTH	OAKLEDGE SOUTH	COVE
Sample:	8.15.90	PARKS		1700	620	180	360	510	180	50
Sample:	8.17.90	PARKS	AM	30	30	30	50			
Sample:	8.17.90	PARKS	PM	200	100	170	80			
Sample:	8.20.90	PARKS		10	10					
Sample:	8.23.90	PARKS		30	<10					
Sample:	8.27.90	PARKS		10	130					
Sample:	8.28.90	PARKS	AM	390	400					
Sample:	8.28.90	PARKS	PM	20	80					
Sample:	8.29.90	Parks		370	380					
Sample:	8-30-90	Parks	AM	30	30					
Sample:	8-30-90	Parks	PM	<10	210					
Sample:	9-7-90	Parks		66	400					
Sam :										

* E. Coli *

"TESTING" BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION Sheet # 90-1

SAMPLES

	SAMPLE DATE BY	LEDDY BEACH NORTH	LEDDY BEACH SOUTH	NORTH BEACH MOUTH	STREAM South Prosp	E.R. Current Shelter	E.R. Mouth	OAKLEDGE South Mouth	EMERSON PARK Gulf Cove A	Gulf Cove B	North Beach Middle	N.B. Head	
Sample:	6/27 TG, J.C.	210	TNTC >1000	~1,600	330	(350)	90		Left	Right			
Sample:	7/11 T.G			240									
Sample:	7.23 S.F	1,500	800	TNTC >10000	2,400	2,500	(6100)	4400	1600	680	2,400	2,500	
Sample:	7.25 SF			2700							1,000	1,500	
Sample:	7.30 SF	160	110	1,960	310	660 / 430	640	410	(1050)	60		840	
Sample:	8.1	200	<100	3,200			(6,300)	600					
Sample:	8.7	1200	300	15,000	6000	5000 / 5000	(9000)	4000	6000	2000		5000	
Sample:	8.13				800	200 / 400	100	(1600)	100	100			
Sample:	8.20	50	<10				<10					1440	
Sample:	8.22				10	370 / (800)	<10	370	10	70			
Sample:													
Sample:													
Sample:													

* E. Coli *

"TESTING"

BURLINGTON PUBLIC WORKS – WASTEWATER DIVISION
WINOOSKI RIVER SAMPLES

Sheet # 90-1

	DATE	~~Main~~ Main CSO	NORTH STORM	MOUTH WR1	DOWNSTREAM NORTH WR2	NORTH WWTP EFFLUENT	UPSTREAM NORTH WR3	DOWNSTREAM EAST WR4	EAST WWTP EFFLUENT	UPSTREAM EAST WR5
Sample:	7/11 T.G.		200			<1			<1	
Sample	7/18 T.G		30	50	110	<1	130	10	<1	310
Sam	7/m T.G.									
Sample	7.23	880,000								
Sample:	7.26		10	370	350		440			
Sample	8.2		50	10	180		70	160		100
Sample:	8.8		220	0	0		0	0		20
Sample	8.15		2200	400	1300	TNTC	1100	700	TNTC	900
Sample:										
Sample										
Sample:										
Sample										
Sample:										

★ E. Coli ★

"TESTING"

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION
SWIM BEACH SAMPLES

Sheet # 90-1

	SAMPLE DATE	SAMPLED BY	LAB	NORTH BEACH NORTH	NORTH BEACH SOUTH (Main)	LEDDY BEACH NORTH	LEDDY BEACH SOUTH (North)	OAKLEDGE NORTH	OAKLEDGE SOUTH (Main)	COVE
Sample:	8·2·90	PARKS		dry 40	dry 10	dry ~~20~~	dry 10	dry 20	dry 10	dry <10
Sample:	8·6·90	PARKS		wet 120	wet <100	wet <80	wet 70	wet 40	wet 40	wet 20
Sample:	8·7·90	PARKS	PM	wet 30	wet 20					
Sample:	8·9·90	PARKS		wet 190	wet 100	wet 10	wet 80			
Sample:	8·10·90	PARKS		wet 40	wet 70					
Sample:	8·13·90	PARKS		wet 10	wet 20	wet 10	wet 150	wet 330	wet 130	wet 80
Sample:	8·15·90	PARKS		wet 370	wet 330	wet 500	wet 80	wet 120	wet 60	wet 20
Sample:	8·17·90	PARKS	AM	wet 30	wet 60	dry 20	dry 70			
Sample:	8·17·90	PARKS	PM	wet 1200	wet 300	dry 80	dry 300			
Sample:										
Sample:										
Sample:										

Fecal Coliform / Fecal Streptococcus Ratio

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION

SAMPLES

Streams into Beaches

75.1

		6/27	7/10	7/16	7/11	7.23	7.25	7.30
Sample:	LEDOY STREAM North	0.15	1.26	0.607				0.20
Sample:	LEDOY STREAM South	0.50	<0.1	0.005				1.43
Sample:	NORTH BEACH STREAM MOUTH	1.95	0.285	0.163	0.162		0.38	1.56
Sample:	NORTH BEACH STREAM MIDDLE			0.355			0.29	
Sample:	NORTH BEACH STREAM HEAD			0.326			0.23	0.45
Sample:	Englesby R. MOUTH	0.15	0.25	0.286				0.86
Sample:	Englesby R. Shelburne	0.29	0.22	0.07				0.53
Sample:	Englesby R. Crescent		0.53	0.03		0.12		0.76
Sample:	Englesby R. S. Prospect	0.37				PINE St. 0.27		0.15
Sample:	Englesby R. Left Golf Course		0.25	0.08		0.10		1.81
Sample:	Englesby R. Right Golf Course		0.07	0.07		0.05		0.04
Sample:	OAKledge South Mouth		0.04	0.103				0.41
Sample:								

< 0.7 : Animal
0.7 - 4.4 : Mixed
> 4.4 : Human

< 0.7 : Animal Source

0.7 - 4.4 : Mixed

> 4.4 : Human

"TESTING"

Fecal Coliform / Fecal Strept Ratio

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION

Sheet # (2)

SAMPLE DATE		8.1	8.7	8.13	8.21					
Sample:	LEDDY North	0.60	0.36	—	0.008					
Sample:	LEDDY South	< 1.0	—	—	0.02					
Sample:	North Stream Mouth	0.82	0.16	—	0.02					
Sample:	North Stream MIDDLE		—	—	—					
Sample:	North Stream HEAD		0.22	—	0.40					
Sample:	E.R. Mouth	1.43	0.06	1.1						
Sample:	ER Shelburne		—	0.33						
Sample:	E.R. Crescent		—	0.57						
Sample:	E.R. Prince St.		—	0.59						
Sample:	ER Golf Left		—	0.20						
Sample:	ER Golf Right		0.008	0.25						
Sample:	Orrkleday SOUTH	0.30	0.05	2.2						
Sample:										

Fecal Coliform / Fecal Streptococcus Ratio

BURLINGTON PUBLIC WORKS - WASTEWATER DIVISION

SAMPLES

Swim Beaches plus Primary

		7/10	7/16	7.23	8.13			
Sample:	North Beach N.				0.13			
Sample:	North Beach South	<0.10			1.0			
Sample:	Leddy Beach North				<1.0			
Sample:	Leddy Beach South				1.07			
Sample:	Oakledge North				0.71			
Sample:	Oakledge South				0.62			
Sample:	Oakledge Cove				0.26			
Sample:								
Sample:	Primary Eff. MAIN	27.70	16.5 M 1.85 8.9 M					
Sample:	Primary Eff. North	13.60	LAB ERROR 12 M					
Sample:	Primary Eff East	2.22	7.4 M 0.80 9.3 M					
Sample:								
Sample:	MAIN CSO			2.95				

<0.7 : Animal

0.7 - 4.4 : Mixed

>4.4 : Human